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GEOGRAPHY OF UNIFOLIOLATE TAXA OF *FRAXINUS* (OLEACEAE)

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ABSTRACT

Consistently unifoliolate forms exist in two North American species of *Fraxinus*: *F. anomala* (unifoliolate *F. anomala* var. *anomala*) and *F. greggii* (unifoliolate *F. greggii* var. *nummularia*). Taxonomic recognition of the unifoliolate forms has been inconsistent, but in each species they occupy a distinct geographic range, allopatric with the multifoliolate forms, are treated here at varietal rank. For each species, the two varietal taxa are mapped. Lectotypes are designated for the typical expressions of *F. anomala* and *F. greggii*.

KEY WORDS: *Fraxinus anomala*, *F. greggii*, Oleaceae, unifoliolate

Unifoliolate forms exist in two North American species of *Fraxinus*: *F. anomala* Torr. ex S. Wats. (the typical expression is unifoliolate) and *F. greggii* A. Gray (var. *nummularis* is unifoliolate). These two species are not closely related within the genus (*F. anomala* in sect. *Dipetalae*, *F. greggii* in sect. *Pauciflorae*; Wallander 2008), and unifoliolate forms also occur sporadically in other species (Wagner et al. 1988). Taxonomic treatment of the unifoliolate vs. multifoliolate forms in *F. anomala* and *F. greggii* has been inconsistent and the most recent classification of the genus (Wallander 2008) treated both species in the broad sense, without recognizing infraspecific variants. The present study documents the geographic distinction of the unifoliolate forms, which supports their recognition as distinct evolutionary and taxonomic entities in both species.

1. **Fraxinus anomala** Torr. ex S. Wats. in King, Rep. Geol. Explor. 40th Parallel [Bot. Fortieth Parallel] 5: 283. 1871. **LECTOTYPE (**designated here): **USA**. Utah. [Emery/ Grand/ Wayne/ San Juan Co.]: Labyrinth Cañon, Grand River, tree 15 ft high, 28 Aug 1859, *Dr. Newberry s.n.* (NY, NY-digital image!, GH-fragment! [packet of fruits] "ex herb. Torrey (NY)"; isolectotype: US, US-digital image!). Protologue: "A small tree, 15 high, first discovered by Newberry on Macomb's Expedition in 1859 in Labyrinth Cañon on the Colorado River, Utah, and again recently collected by Palmer near St. George on the Rio Virgen in the southwestern portion of the State." SYNTYPE: Utah. Washington Co.: near St. George on the Rio Virgen, 1870, *Dr. E. Palmer s.n.* (GH! mounted on sheet with 3 other fragmentary collections; possible duplicate, US digital image!, "S. Utah, 1877, *Dr. E. Palmer*," mounted with lectotype of *F. anomala*).

1a. Fraxinus anomala var. **anomala**

1b. Fraxinus anomala var. **lowellii** (Sarg.) Little, J. Wash. Acad. Sci. 42: 370. 1952. **Fraxinus lowellii** Sarg. in Rehder, Proc. Amer. Acad. Arts 53: 211. 1917. **TYPE**: **USA**. Arizona. Coconino Co.: Oak Creek Canyon, [S of] Flagstaff, shrubby tree, 25 feet tall, 13 Jul 1914, *A. Rehder 53* (holotype: GH!; isotypes: GH-2 sheets!, MO!, NY-digital image!, US-digital image!).

Fraxinus anomala var. *triphylla* M.E. Jones, Proc. Calif. Acad. Sci., ser. 2, 5: 707. 1895. **TYPE**: **USA**. Arizona. [Mohave Co.:] Pagumpa, among rocks, at the lower edge of the juniper belt, in the Grand Wash, 4000 ft, 20 Apr 1894, *M.E. Jones 5082* (holotype: US, US-digital image!).

Fraxinus anomala in its typical expression in unifoliolate (hence the epithet); var. *lowellii* is multifoliolate. Wilken (1993) treated the species in California without reference to infraspecific variation. Both Holmgren (1984) and Welsh et al. (2003) treated *F. anomala* var. *triphylla* as a synonym of *F. anomala* sensu lato (as inferred from their geographical summaries) but did not mention *F. lowellii* at the rank of species or variety. The PLANTS Database (USDA-NRCS 2009) recognizes var. *lowellii* but restricts it to Arizona. As seen in Fig. 1, there are two geographic entities and the morphological distinction between them is clear. Variants within each entity, however, suggest that genetic divergence between the two is minimal. It is not apparent that gene flow underlies the variation, especially in var. *lowellii*, where trifoliolate variants (see comments below) occur over its whole range, not just in the area where it closely approaches the typical element of the species. The species is regarded here as constituting two essentially parapatric varieties, perhaps slightly allopatric in southern Nevada and possibly California.

Localities for *Fraxinus anomala* in the Utah Atlas (Shultz et al. 2006) show a fuller distribution but the overall pattern is nearly identical with that mapped here. Similarly, localities from Seinet (2009) add some density to the distribution in Arizona but do not alter the overall pattern. Miller (1955) included "Wyoming" in the geographical summary for the species, but it has not been treated for the state in floristic summaries (e.g., Dorn 2001).

In the original description of *Fraxinus lowellii*, Rehder (1917) cited collections from Coconino, Yavapai, and Mohave counties and distinguished it in a key from *F. anomala* by its leaves "pinnate, 3–7-foliolate" (vs. leaves "simple, only occasionally 3-foliolate"). He noted (p. 212) that "This very distinct species [*F. anomala*] occurs within our area only in northern Arizona and in the extreme northwestern corner of New Mexico and extends into Utah and Nevada. It shows little variation; the variety *triphylla* Jones can hardly be considered a distinct form or variety, as trifoliolate leaves are likely to appear on any vigorous shoots of normal simple-leaved plants." In relegating *F. lowellii* to synonymy, Miller (1955, p. 50) noted that "the type of leaf and the variability in shape are results of the genetic variability of *F. anomala* expressed throughout its range, and need not be named." Shreve & Wiggins (1964, p. 1086) relied on a more typological justification: "Both simple and trifoliolate leaves occur on an occasional shrub, hence the varietal recognition of the trifoliolate variant is unwarranted."

In the range of var. *anomala*, leaves are consistently 1-foliolate, but occasionally on fast-growing shoots, groups of 3-foliolate leaves are produced. At the tips of spur shoots, the leaves apparently usually are 1-foliolate, even on the branches where 3-foliolate leaves are produced on the distal shoots—e.g.: California, San Bernadino Co., Providence Mts., 31 Jul 1940, *Wolf 9732* (TEX); Nevada, Clark Co., canyon E of Mountain Springs, 22 Apr 1939, *Clokey 8453* (GH); Utah, [Emery Co.], San Rafael Swell, 11 May 1914, *Jones s.n.* (GH). In label notes for *Cronquist 10024* (TEX) from Kane Co., Utah, the collector noted "leaves typically simple but often some of them 3-foliolate or lobed, especially on vigorous shoots. A few plants with the leaves largely trifoliolate, even on short spurs." Welsh et al. (2003) noted that in Utah "Uncommonly some of the leaves are modestly compound with a pair of leaflets below the terminal one."

In the range of var. *lowellii*, leaves are consistently 3–5-foliolate, but 1-foliolate ones sometimes are produced on mostly multifoliolate plants. In the Mazatzal Mountains of Maricopa Co., Arizona, an area where many collections of typical var. *lowellii* have been made (especially around Payson and Pine), Susan McKelvey made numerous collections on the "road to Amethyst Mine" (11 May 1929). Of three sheets of *967* (perhaps the same tree), two have branches with 3–5 leaflets, while one has two branches with 3 leaflets and two branches with single leaflets arising from young shoots. Other collections by McKelvey (*890*, *961*, *964*) from the same area, on the same day, have

3(–5) leaflets. In the Mogollon Mountains of southwestern New Mexico, a collection by E.L. Greene (27 Apr 1881, *Greene s.n.*, GH) has 3-foliolate leaves on shoots with 1-foliolate leaves at the spur tips.

2. Fraxinus greggii A. Gray, Proc. Amer. Acad. Arts 12: 63. 1876. **LECTOTYPE** (designated here): **Mexico**. [Coahuila]. Low grounds near Rinconada, 5 Jan 1847, *J. Gregg s.n.* (GH 73811!). After the brief protologue description, Gray cited "*F. Schiedeana* var. *parvifolia*, "Torr. Bot. Mex. Bound. 166. — S. W. Texas, and adjacent parts of Mexico, Gregg, Schott, Bigelow, Parry." Two syntypes are mounted on the same sheet as the lectotype: USA. Arizona. Near Painted Caves, 18 Sep 1852, *J.M. Bigelow s.n.* (GH 73813); Mexico. [Coahuila]. Santa Rosa Mountains, no date, *J.M. Bigelow s.n.* (GH 73812). The type locality (La Rinconada) is about 30 kilometers directly south of the center of Monclova.

Fraxinus schiedeana Schltdl. & Cham. var. *parvifolia* Torr., Rep. U.S. Mex. Bound. 2(1): 166. 1859. **LECTOTYPE** (designated here): **Mexico**. [Coahuila]. Low grounds near Rinconada, 5 Jan 1847, *J. Gregg s.n.* (GH 73811!). Protologue: "Rocky places in limestone districts on the Rio Grande, from the San Pedro to the Pecos; *Schott*. Mountains of Santa Rosa, Coahuila; *Bigelow, Parry*." As lectotypified here, this taxon is homotypic with *F. greggii*.

2a. Fraxinus greggii var. **greggii**

2b. Fraxinus greggii var. **nummularis** (M.E. Jones) Little, J. Wash. Acad. Sci. 42: 375. 1952. *Fraxinus nummularis* M.E. Jones, Contr. Western Bot. 12: 59. 1908. *Fraxinus greggii* forma *nummularis* (M.E. Jones) C.H. Mueller, Amer. Midl. Naturalist 3: 187. 1914. *Fraxinus greggii* subsp. *nummularis* (M.E. Jones) A.E. Murray, Kalmia 15: 11. 1984. **TYPE**: **Mexico**. Coahuila. Sierra Mojada, 19 Apr 1892, *M.E. Jones s.n.* (holotype: US, US-digital image!).

Miller (1955, p. 54) observed that the 'nummularis' form is "the designation of a varietal extreme within a rather wide genetic variability found in the shape and texture of the leaves of *Fraxinus greggii*." In the Texas manual, Correll and Johnston (1970) did not include synonyms for *F. greggii* or note even the possible occurrence of infraspecific variation. Powell (1997) included var. *nummularis* as a synonym. Almost all of the unifoliolate populations, however, are in northwestern Mexico where critical comparisons in a broad floristic summary have not yet been made. In a pattern analogous to that in *F. anomala*, the unifoliolate plants of *F. greggii* (var. *nummularis*) are geographically distinct from the typical multifoliolate ones (Fig. 2), and the species is treated here as comprising two parapatric (or slightly allopatric) varieties.

Of two collections by Johnston & Mueller from Picachos Colorados, *129* is 3–5-foliolate, while *130* (GH) is mostly 1-foliolate; *130* (LL) has a mixture of 1- and 3-foliolate leaves. From the Sierra del Pino, *Johnston & Muller 387* (GH, LL) and *387A* (GH) have a mixture of 1-foliolate and 3-foliolate leaves; *387B* has all 1-foliolate leaves. From the Sierra Almagre, *Johnston & Mueller 1217* and*1218* have very small, very broadly obovate leaves.

Similar variation occurs in Brewster Co., Texas, where the two expressions occur together. Because the var. *nummularis* has not previously been recognized in the USA, vouchers are cited here: Texas. Brewster Co., Chisos Mts.: Big Bend Natl. Park, Window Trail, 17 Jun 1963, *Correll & Wasshausen 27893* (LL); Aug 1936, *Hinckley s.n.* (TEX-2 sheets); S-facing slope on trail from Basin to Laguna Meadows, 5800 ft, 12 Mar 1978, *Moir s.n.* (TEX); 9 Jul 1931, *Mueller 8113* (MO); rocky slopes and banks of canyons, 23 May 1928, *Palmer 34116* (MO); Chisos Basin, common, N and E exposures of limestone ridges N of Ward Mt., 19 Aug 1969, *Whitson 433* (SMU); Nail place, 11 Aug 1915, *Young s.n.* (TEX). Examples of typical, 3-5-foliolate plants from the Chisos Mountains are these: trail to Laguna, 21 Jul 1957, *Correll & Johnston 18288* (LL); Window Trail, 7 Jul 1944, *Cory 44744* (TEX).

Attributions of *Fraxinus greggii* to Arizona, New Mexico, and Sonora (e.g., USDA-NRCS 2009) have been of collections now identified as *F. gooddingii* and *F. cuspidata*. "In Arizona Flora, this specimen [*Goodding s.n.*, from Santa Cruz Co., the type of *F. gooddingii* Little] was cited under *F. greggii*, a species of southwestern Texas and northeastern Mexico" (Kearney & Peebles 1969).

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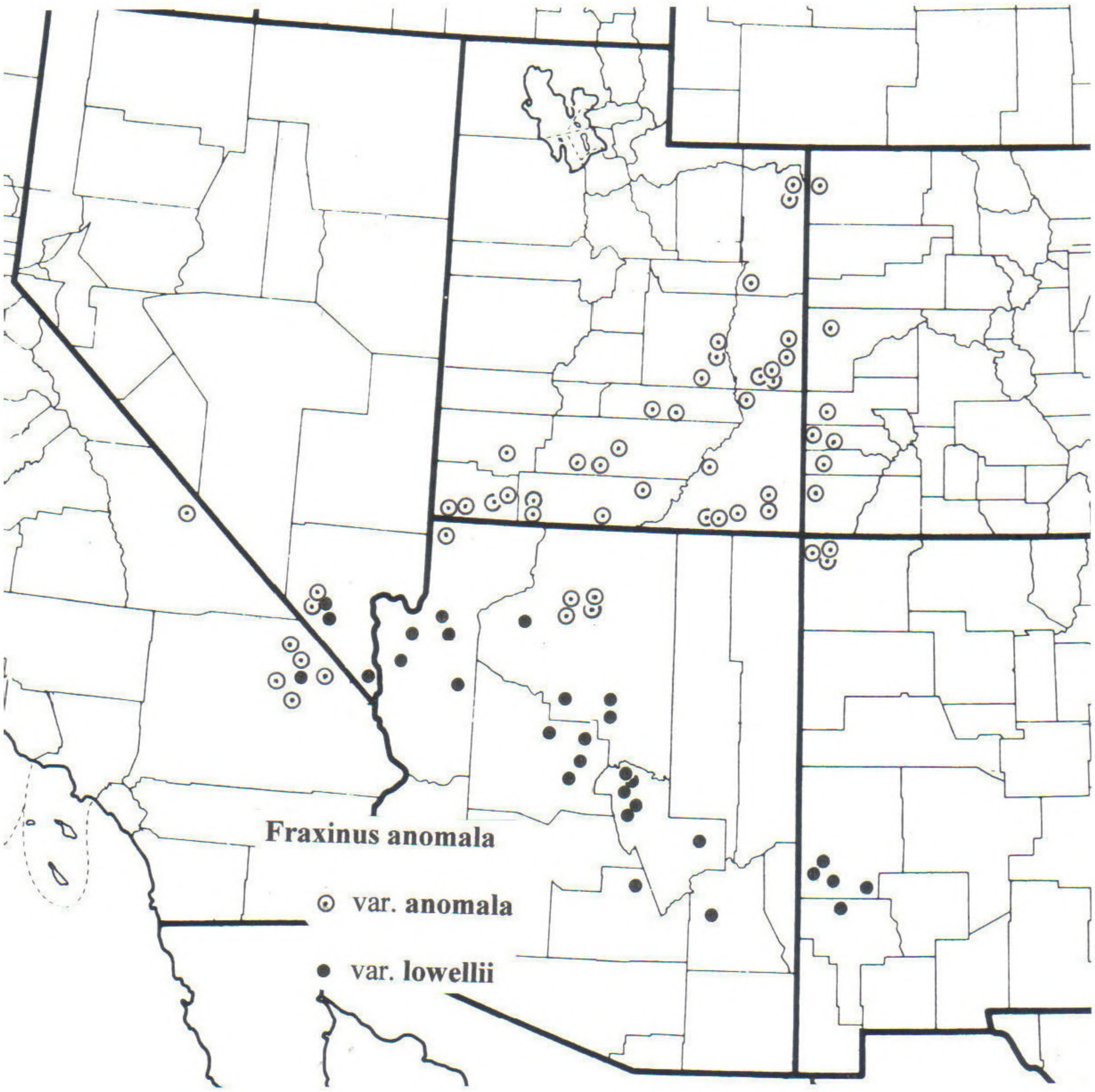

Figure 1. Distribution of *Fraxinus anomala* var. *anomala* and var. *lowellii*.

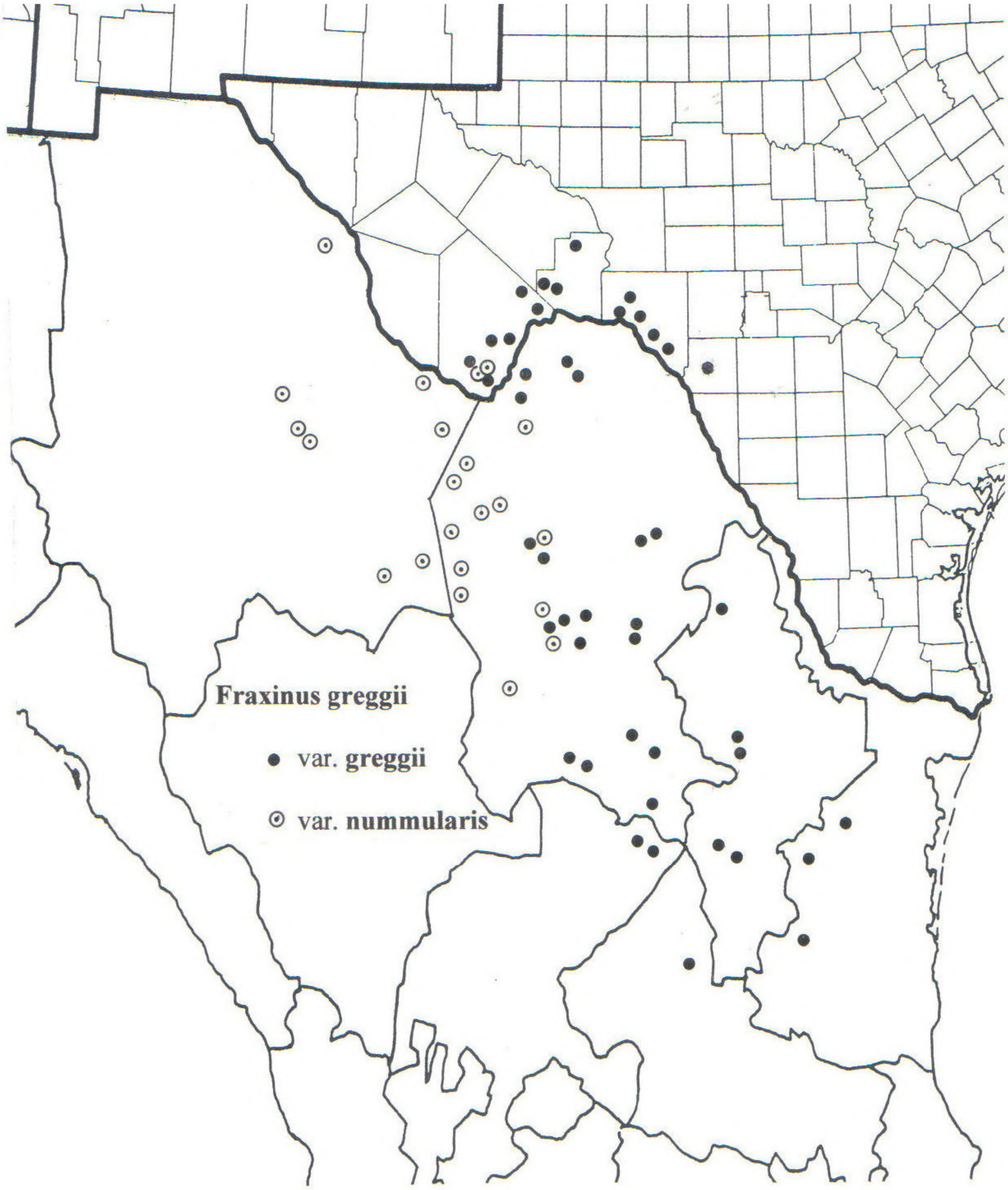

Figure 2. Distribution of *Fraxinus greggii* var. *greggii* and var. *nummularis*.